



# MULTI AXIS MOTION CONTROLLER



1, 2 or 3 axis control.

Linear, circular & tangential interpolation.

Standard ISO G-Code language.

Suitable for stepper or servo motors.

Stand alone or computer operation.

Optional CAD file DXF/HPGL conversion.

Programs downloaded from PC.

Compatible with R.T.A. Stepper drives.

The S & H GOYA controllers are CNC multi axis controllers for automatically controlling machines using stepper or servo motors. They are designed for synchronised motion where two or more axes are run simultaneously. Motion programs are written in ISO (G-Code) which is easy to use and is familiar to most CNC machine operators. Programs can be written using the 'BACH' PC based software which allows operators to edit and verify programs before downloading them to a controller via the RS232 port.

It is not necessary to the Windows based S & H software, it is possible to send the program files as ASCII characters using other software written by the machine manufacturer. Programs can be stored in the controller and executed as required. The controller can be used independently of a PC as programs are stored in a non volatile memory. Typical applications are XYZ profiling tables, pick & place, automatic welding, engraving, packaging machines, glueing & painting.

## SPECIFICATIONS

### POWER SUPPLY REQUIREMENTS

24 VDC @ 6W

### ENCLOSURE

DIN 144 x 144mm (panel) X 156mm aluminium panel mounting (cut out 139 x 139mm)

### WEIGHT

1kg

### OPERATING TEMPERATURE

0 to 45°C

### DIGITAL INPUTS

16 off, +12 to +35 VDC  
opto isolated  
(some required for limit+, limit- and datum inputs)

### DIGITAL OUTPUTS

8 off, +12 to +35 VDC @ 300mA  
opto isolated

### SERIAL PROTOCOL

9600 baud, 8 data bits, ODD parity, 1 stop bit

### STEPPER DRIVE SIGNALS

Step, direction, drive enable, drive fault  
100kHz max, 15 bit resolution  
NPN current sink or 5V TTL

### SERVO DRIVE SIGNALS

Velocity, direction, drive enable, drive fault  
+/- 10V, 2 bit resolution

### ENCODER INPUTS

5V differential  
Maximum 250kHz

### CONNECTORS

(on rear panel)  
Drives: D9 male  
Encoders: D9 female  
Inputs/Outputs: D37 female  
RS232: D9 male  
CAN BUS: D9 male  
Analog input: D9 female

### PROGRAM MEMORY SIZE

200000 characters stored in GOYA

### Number of Axes

The GOYA series by S & H are available with 1, 2 or 3 axes of movement. The 3rd axis, if used, must always be a stepper motor. If more axes are needed, the S & H 'REUBENS' series can control upto 6 axes but it does not have a keypad or display.

### Power Supply

The GOYA requires a 24 VDC supply, although this may be between 19 and 35 VDC. The maximum power requirement is 6 Watts and the supply must be smoothed.

### Motors

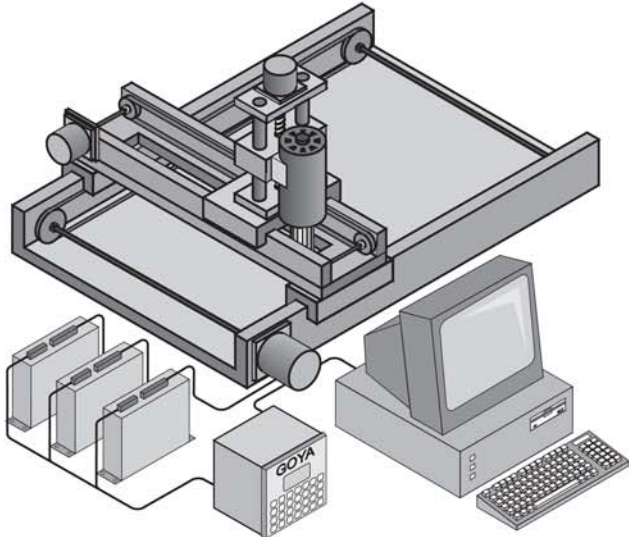
GOYA versions are available for both stepper and servo motors. For steppers the control output signals are step, drive enable and direction. For servo motors the control outputs are +/-10V velocity demand and drive enable with encoder feedback. Both brushed and brushless servo motors are compatible.

### Stepper Drives

There are two main types of stepper drive input. These are voltage inputs and open collector current sink inputs for step, direction and enable. The GOYA is compatible with both types of drive, including the RTA GMD, GMH, GAC, BCW, SAC, HDG, SDC and MIND drives.

### Position Control

Stepper motors are usually run in open loop control (without feedback). However, the GOYA can be supplied with optional encoder inputs to close the loop in stepper systems. Servomotors are inherently closed loop so don't require this option.



### Inputs

The GOYA has 16 digital inputs. These are optocoupled and must be switched high to +12 to +35 VDC for logic high. Normally, 24 VDC is used and this may be the same as the 24 VDC supply for the GOYA. These inputs can be read by a motion program. Nine of these inputs are dedicated to limit and datum switches for all the axes. It is also usual to dedicate one input to an emergency stop.

### Speed profiles

The GOYA has built in ramping and is capable of trapezoidal, parabolic and 'S' type velocity profiles.

### Outputs

The GOYA has 8 digital outputs. These are also optocoupled, switching +24 VDC at upto 300mA. It is permissible to use the same power supply as the GOYA. These outputs can be switched on and off by the motion program. They can be used to switch on cutter tools, clamps, solenoids, punches etc.

### Limits & Datums

Each axis in a machine will require limit and datum switches for each axis (limit-, limit+ and datum). It is usual to use normally closed switches as they are failsafe. Upto nine of the inputs (depending on model) are dedicated to limit and datum switches as follows:

Input 6	<i>Datum Z axis</i>	Input 11	<i>Limit + Y axis</i>
Input 7	<i>Datum X axis</i>	Input 12	<i>Limit - Y axis</i>
Input 8	<i>Datum Y axis</i>	Input 13	<i>Limit + Z axis</i>
Input 9	<i>Limit + X axis</i>	Input 14	<i>Limit - Z axis</i>
Input 10	<i>Limit - X axis</i>		

### Emergency Stop

When an emergency stop button is hit (a normally closed switch connected to one of the inputs) the drives will all de-energise. The machine cannot be re started until the GOYA is reset. Normally, an emergency stop safety circuit will also cut off power to the drives and other components that could cause injury.

### Interpolation

The GOYA controllers are capable of linear and circular interpolation. Linear interpolation can be on the XY, YZ and XZ planes. Also, linear interpolation is possible in 3 dimensional space (XYZ). Circular interpolation can occur on either of the XY, XZ or YZ planes.

### Tangential control

Apart from interpolation, the GOYA can control a knife cutter and maintain its tangent to the path to be cut.

### 3D Motion

The GOYA can control motors in 3 dimensional space, but it is not intended for full 3D sculpturing. It is possible to machine a curve in 3 dimensional space by breaking such a curve into small linear segments in XYZ space and running the motors 'point to point', however the programming can be tedious.

### Motor Speeds

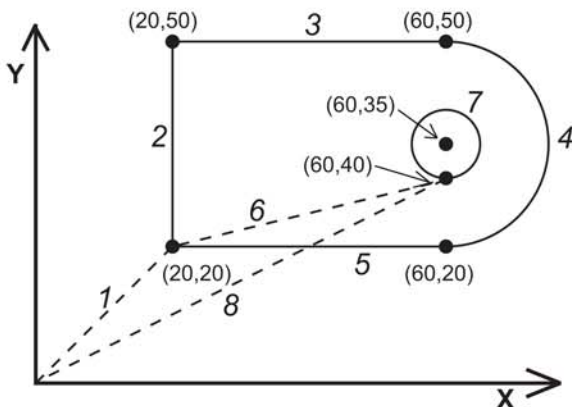
Motor speed is determined by the maximum step output frequency of 100kHz for the stepper model GOYA and the maximum encoder input frequency of 250kHz for the servomotor or stepper & encoder models. For example, if you are using an open loop stepper motor drive with 4000 steps/rev resolution, the maximum motor speed will be  $100000/4000 = 25$  revs/sec.

### Time delay

Time delays (dwell) are useful in machines where motors must wait until a machining operation is complete. This is possible with the GOYA language using the G04 command. Time delays from 0.01 to 9999.99 seconds are possible.

## Programming Language

The motion language is 'ISO' of G-Code which is used on CNC machine tools. Machine operators will be familiar with this and it won't be necessary to use computer programmers to program the controller. The G-Code commands are listed at the end of this brochure. Some commands will not be available in models without interpolation. An example of a G-Code program is shown in the diagram. This could be a router, oxy cutter, laser or plasma cutter.



PATH	CODE	DESCRIPTION
1	G00 X20 Y20 F1000 G00 Z20 F500 G68 P1	Goto (20,20) rapidly, speed 1000mm/min Lower Z to 20mm at 500 mm/min Turn output 1 ON
2	G01 X20 Y50 F300	Goto (20,50), speed 300mm/min
3	G01 X60 Y50	Goto (60,50) at same speed
4	G02 X60 Y20 I60 J35	Clockwise arc ending (60,20), centre (60,35)
5	G01 X20 Y20 G67 P1 G00 Z0 F500	Goto point (20,20), same speed Turn output 1 OFF Raise Z axis to 0mm at 500 mm/min
6	G00 X60 Y40 F1000 G00 Z20 F500 G68 P1	Goto (60,40) rapidly, speed 1000 mm/min Lower Z to 20mm Turn output 1 ON
7	G02 X60 Y40 I60 J35 F300 G68 P1 G00 Z0 F500	Arc ending at (60,40), centre (60,35) Turn output 1 OFF Raise Z to 0mm at 500 mm/min
8	G00 X0 Y0 F1000	Goto datum 1000 at mm/min

### Speed change

Speed is defined by the 'F' command in the program. Overall speeds (all axes) can also be manually changed while the program is still in operation by keys on the front panel or computer screen.

### On the fly speed change

At times it is necessary to change speed of a motor, according to a program, while still in motion and without stopping the motor. This can be achieved by the G57 and G58 auto linkage commands.

### P.L.C.

Often, a machine also requires a lot of logic switching and monitoring as well as motor control. The GOYA can be provided with a P.L.C. option, expandable up to 128 inputs and 128 outputs using CAN bus. The PLC function which is programmed in ladder logic runs independently from the motor control.

### Protection

The GOYA has inbuilt password protection preventing unauthorised use of a machine. Furthermore, when controlling the GOYA from a PC, different machine operators can be assigned different passwords depending on competence and level of options available.

### Analog Inputs

The GOYA can be supplied with optional 6 analog inputs, 0-5V, 10 bit and a +5V DC excitation for potentiometers and sensors. These analog inputs can be read by a program.

### Analog Outputs

The GOYA can be supplied with 2 optional analog outputs, +/- 10V, 12 bit. This option is only available with the stepper versions of GOYA.

### Engineering Units

All programming is done in engineering units such as millimeters or inches and not motor revs, steps or encoder pulses.

### Precision

Theoretical positions are accurate to 6 decimal places, however, for simplicity, the user can program the desired number of places displayed.

### Continuous Execution

Using the G57 and G58 commands, the GOYA will perform continuous execution of segmented paths. This is essential in cutting applications where a stationary cutting tool will burn the workpiece.

### CAM function

The GOYA can also perform a CAM function. This is to run a motor at a particular velocity profile according to a lookup table of speeds versus distance.

### Master/slave

The GOYA can also run a motor at a programmed speed ratio to a machine, as sensed by an encoder. This can be used to control feed speeds at a ratio to spindle speed for thread cutting.

### Variable management

The GOYA can also perform mathematical operations on variables (eg. obtained from analog inputs). Operators are + - \* / ^ and square root.

### Housing

The GOYA is housed in a panel mounting aluminium extruded DIN 144 x 144mm case (CAMA R2082-145). Brackets are supplied to mount it in a panel cut out, 139 x 139mm. All connections are at the rear of the GOYA. Although the depth of the case is 148mm, allow 217mm for connectors at the rear.

### Probe

For scanning it is necessary to have a probe input to sense position. This is possible as the GOYA inputs are high speed. An axis is moved at a defined speed using the G06 command and as soon as the probe is hit, the motor will stop and the position can be read by the GOYA.

### Wait

When machining, it is sometimes necessary for the GOYA to wait and not move motors to the next position until it is clear and an input is sensed. This can be done using the G66 'hold input' command.

### Loops

If you had to machine a large number of identical items the program would be long. It is possible to write a program for one item and repeat it many times in an array.

### GOYABOX

The standard GOYA is supplied with a keypad and numeric display. This enables an operator to select programs and manually jog or datum the machine. In applications where the GOYA will be controlled by a computer or programs are rarely changed, a lower cost version called the GOYABOX can be supplied. The keypad and display are replaced by a blank aluminium plate.

### Settings

When setting up the GOYA there are numerous settings such as motor speeds, acceleration rates, input switch logic, scaling factors etc. Once these are programmed and stored in the GOYA memory, an unauthorised operator will not have access to them.

### Subroutines

When run in stand alone mode, the GOYA can support subroutines (nested to 8 levels) to make program size smaller.

### Control

The GOYA has a serial port, allowing it to be interfaced to a PC running Windows 95 or 98. Using the S & H BACH software, programs are written, saved, edited, graphically verified and then sent to the GOYA. The dongle protected BACH software is written by the manufacturers of the GOYA.

There are two modes of operation with the GOYA. In the first mode, the computer is controlling the machine and motion programs are sent to the GOYA in packages as the machine is running. This is useful for very large programs where you want to view status on the screen.

In the second mode, motion programs are downloaded into the GOYA and then saved in a non volatile memory. Then a program can be run by selecting the required program from the GOYA keypad and display and starting. The computer does not need to be connected for this operation!

The memory in the GOYA is about 150000 characters. A typical G-Code program line like "G01 X150.0 Y20.0 F300" consists of 21 characters so you could fit 7142 lines of code similar to this. The maximum number of programs is 100.

### Downloading Software

If you do not wish to use the BACH software to download programs, it is possible to do this yourself. The motion program just consists of ASCII codes and the GOYA manuals provide all the data transfer commands to send programs through the comms port. This is handy if you have a small number of GOYA programs that are used repetitively and are rarely changed. However, you will need an experienced computer programmer for these applications.

### Programming without Computer

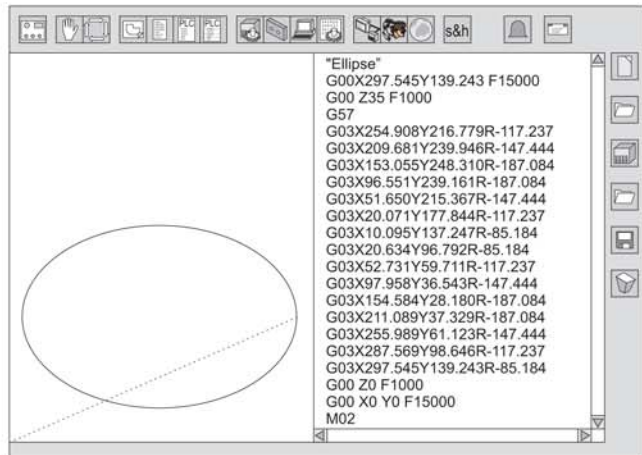
It is possible to edit and enter motion programs into the GOYA using the keypad and display. This does not require a computer. However, the procedure is not recommended for large programs as it can be very time consuming and has a high error rate.

### Manual Jogging

It is possible to manually jog axes on the machine, either when the GOYA is linked to a computer or running alone. When using BACH, jogging can be done by clicking on an axis icon and pressing arrow keys for continuous motion or moving a set distance at a time. The machine can be datumed by clicking on a datum icon.

### BACH Lite

The GOYA is supplied with BACH Lite software at no cost. This does not allow you to download motion programs. It enables you to set up the GOYA to the correct machine parameters such as scaling, speeds, accelerations and inputs.



**BACH 2000 - PROGRAM EDITING**

### BACH 2000

This is the full version of BACH and allows you to download programs into the GOYA and operate the GOYA from a computer. To use this software a dongle is required.

### Computer mouse

When running GOYA from a computer, functions can be selected using a computer mouse. However, mice do not survive long in a harsh environment so keyboard arrow keys, F10 and return keys can also be used.

### Flexible program files

The programs saved by the BACH software are basic ASCII text files. You don't need special codes to read them. You can read them and edit them on a word processor if you want. You can use other CAM packages to generate the program and read them with the BACH software. You could even write a program with the mathematics to generate the lines of code for small linear segments (such as a 3 dimensional shape) and save the file to a disk. The BACH software is not particularly sensitive about formatting the lines of code but commas and stops cannot be used.

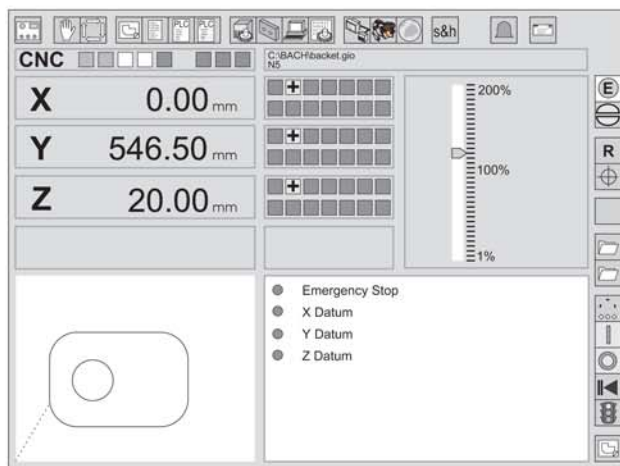
**G01 X100 Y50 Z40 F1000** OK  
**G01X100Y50Z40F1000** OK to omit spaces  
**N20 G01 X100 Y50 Z40 F1000** Line numbers OK

**G01 X100 Y50** OK to omit 'F' command  
Controller assumes same F as before

**X100 Y50** OK to omit 'G' command  
Controller assumes same G as before

**g01 X 100 Y 50 Z 40 F 1000** Not acceptable  
No spaces or lower case

**G01,X100,Y50,Z40,F1000** Not acceptable  
No commas allowed.



### **BACH 2000 - MACHINE CONTROL**

#### Terminal Mode

When running the GOYA from a computer and when first testing a system, it is useful to be able to send single lines of G-Code to the GOYA. This can be done by the terminal mode that lets you type a single line and download it by pressing return.

#### Teach mode

When using the BACH software, complex shapes can be programmed by manually jogging motors to point positions and clicking enter which automatically generates a line of code in the program. This is useful when programming shapes that are not easily mathematically defined and where accuracy is not critical.

#### Safety

It is the machine manufacturer's responsibility to assess the safety risks and ensure the machine conforms to AS4024-1

### CAD files

For complex shapes consisting of curves, arcs and lines, calculating points and typing lines of code can be difficult. It is easier to draw them using a CAD software package. The BACH software has an option that allows importing DXF and HPGL files produced by CAD software and converting them into motion programs. Subroutines for beginning and end of a profile (eg. tool on, tool off) can be defined and automatically inserted into the program.

### Program size reduction

It is often necessary to machine a profile that consists of many interpolated lines and arcs. A typical example is the sole of a shoe. Because the shape was probably generated by CAD software, it may consist of many small straight lines joined together. The program length can be enormous, taking up valuable memory space in the GOYA. The BACH software has an option of post processing the program and replacing a long list of linear moves with a very short list of arc moves.

### Tool Radius Offset

Cutting tools remove material and therefore have a 'kerf' which must be allowed for when programming. Rewriting lines of code if the paths are circles, arcs and rectangles is easy but when paths are curves or regular shapes on an angle this can become difficult. BACH is available with an option (extra cost), allowing you to change sections of program code to compensate for tool radius offset. This uses the G40, G41 and G42 commands. When this feature is used, the program must be run from the computer using the BACH software and may not be stored in the controller. The controller is not able to do the real time processing required.

### Video replay

When using servomotors, tuning the drive and GOYA can be critical. To assist in doing this, the BACH software enables you to program a motor move and look at the response on the computer screen, graphed as coordinates and velocities with respect to time. The theoretical response can be compared to actual response. This feature is not available with stepper motors without encoders as there is no way of knowing actual position.

### EMC

The GOYA is CE marked and complies with electromagnetic compatibility standard 89/336/EEC and should be installed according to the Appendix to hardware manual "CNC1, Appendix to User's manual for S & H Controllers" It is the machine manufacturer's responsibility to ensure the machine conforms to Australian EMC Framework. Our EMC statement applies and is available on request.

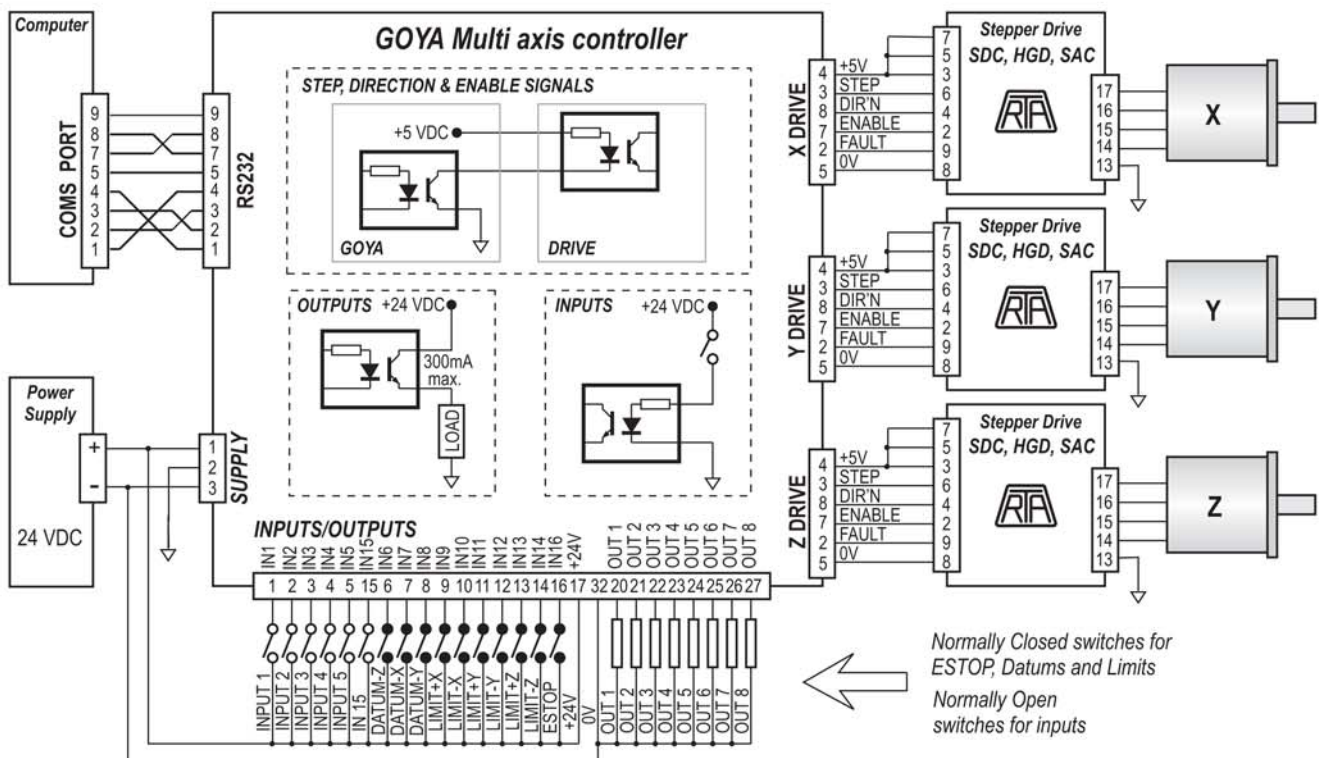
### Installation

We strongly recommend that a competent engineer familiar with mechanical, electrical, electronic and computer systems be involved with the installation and setup of the GOYA controller.

## SUPPORTED COMMANDS

G00	Rapid move (no interpolation)	G53	Origin of axes at this point
G01	Move with interpolation	G54	Origin of axes at this point (software set)
G02	Clockwise circular Interpolation	G55	Save current origin
G03	Anticlockwise circular Interpolation	G56	Restore origin set by G55
G04	Dwell (time delay)	G57	Activate continuous velocity
G06	Run axis continuously	G58	Deactivate continuous velocity
G16	Define plane of circular interpolation	G61	Activate accurate stop
G17	Select XY plane for circular interpolation	G62	Deactivate accurate stop
G18	Select XZ plane for circular interpolation	G63	Activate 'don't wait for end of movement'
G19	Select ZY plane for circular interpolation	G64	Deactivate 'don't wait for end of movement'
G20	Unconditional jump	G65	Wait for input to go low before proceeding
G21	Jump if flag TRUE	G66	Wait for input to go high before proceeding
G22	Jump if flag FALSE	G67	Switch output OFF
G25	Define minimum limits	G68	Switch output ON
G26	Define maximum limits	G69	Assign state of flag
G27	Cancel work limits	G70	Units in inches
G30	Recall subroutine	G71	Units in millimetres
G31	Recall subroutine if flag TRUE	G80	Enable/Disable cam table
G32	Recall subroutine if flag FALSE	G81	Define DISENGAGE cam positions
G50	Cancel displacement of origin	G82	Define automatic cam table
G51	Seek Datum switch	G83	Define cam factor
G52	Displacement of origin	G84	Define cam velocity variations
G90	Activate absolute coordinates	G94	Deactivate tangential tool guide
G91	Activate relative coordinates		

## TYPICAL SCHEMATIC



Continuous development may necessitate changes in specifications without notice.  
Motors, drives, belts & pulleys and gearheads also available.

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